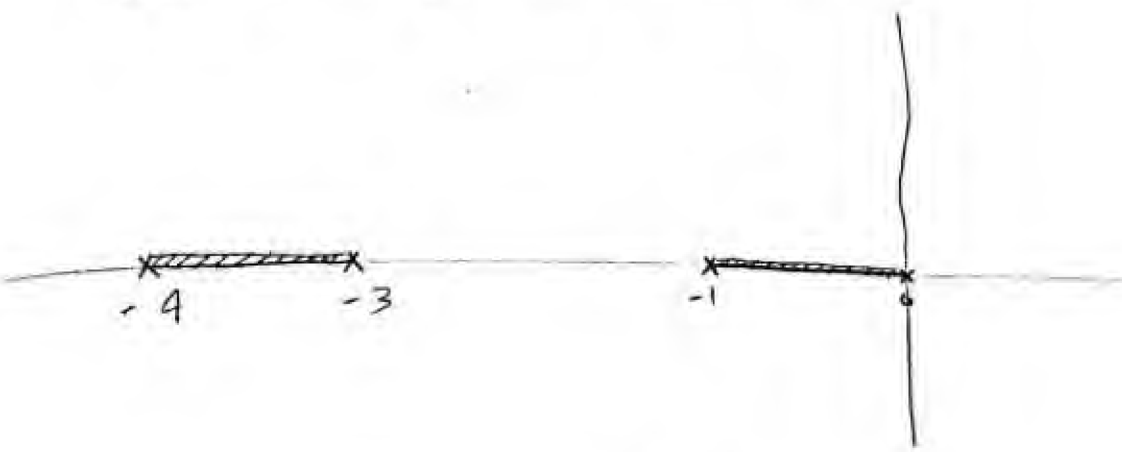
Sec 2 Control

Root locus

$$GH(s) = \frac{K}{s(s+1)(s+3)(s+4)}$$

① on the sketch determine (plot) open loop poles and zeros $n_p = v$ $n_z = v$

② Determine the parts of the real axis that belong to root locus.



the parts of the real axis located at the left of odd number of o.L. poles and zeros Belong to root locus

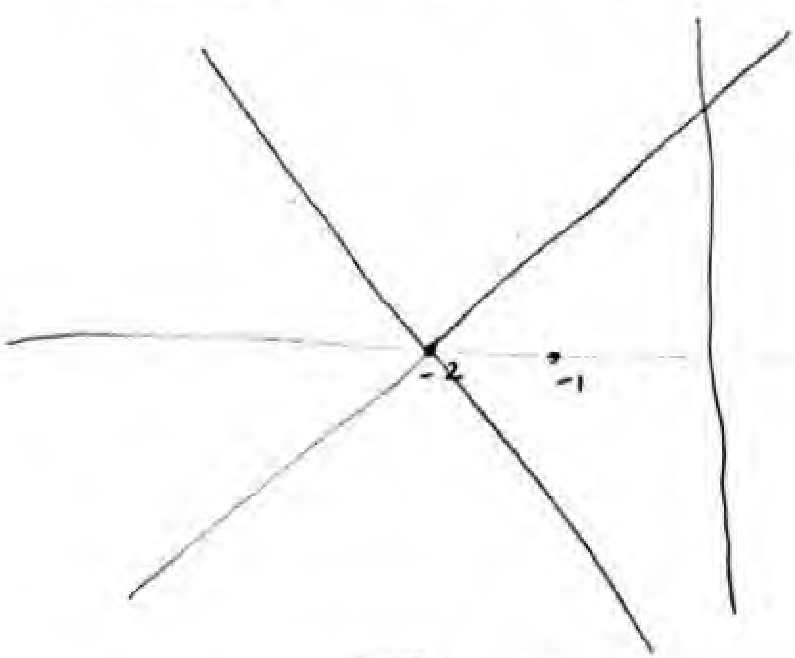
③ Asymptotic lines

number $= n_p - n_z = 4$

$\sigma = \dfrac{\sum p - \sum z}{n_p - n_z} = \dfrac{-1-3-4}{4} = -2$

$\theta = \dfrac{(2L+1)\times 180}{n_p - n_z}$, $L = 0, 1, 2, \ldots$

$\theta = \cancel{45, 135, 225}\ \pm 45, \pm 135$



$\boxed{2}$ Sec2

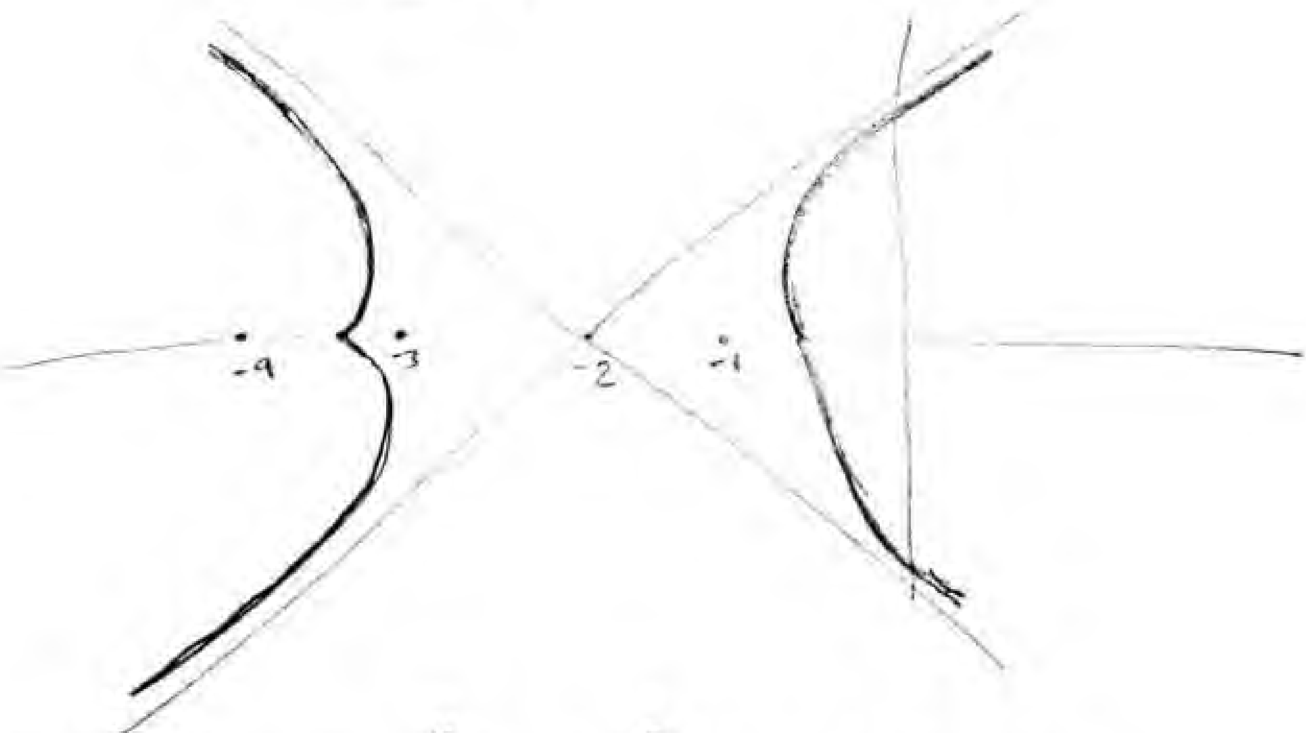
④ Breaking-Points :-

$$K = \frac{-1}{GH(s)}$$

$\frac{dK}{ds} = 0$ solve for s

for higher order system

$$K = \frac{-1}{GH(s)}$$



5 Range of K for stability

Routh

$$1 + GH(s) = 0$$

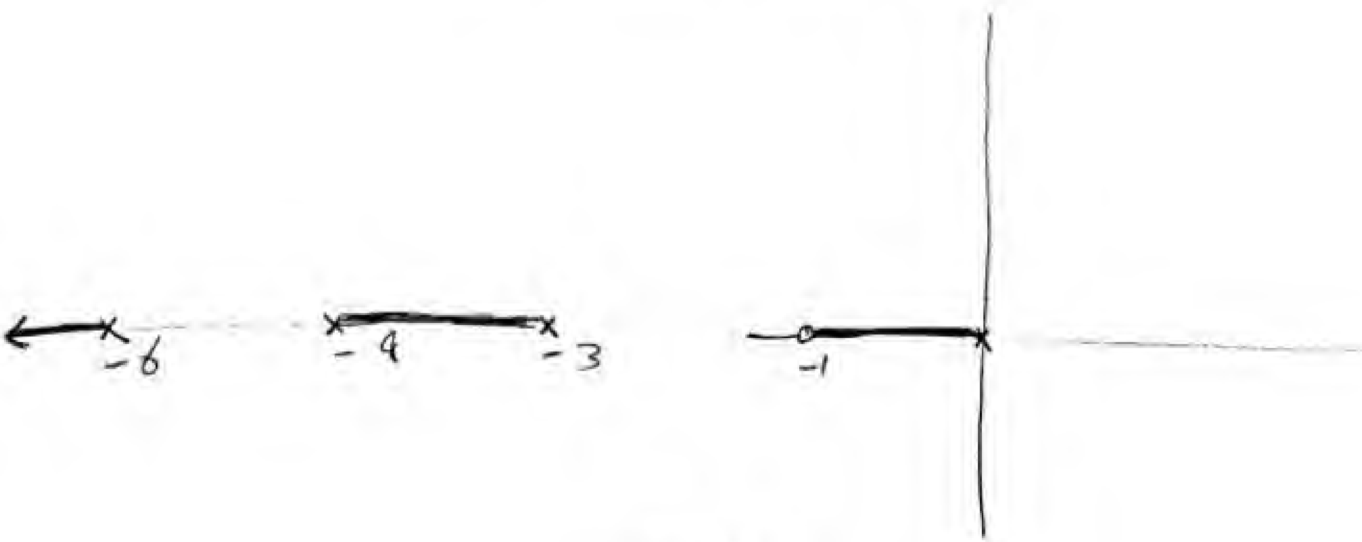
$$s(s+1)(s+3)(s+4)+K=0$$

$$s^4+8s^3+19s^2+12s+K=0$$

$$\begin{array}{c|ccc}
s^4 & 1 & 19 & K \\
s^3 & 8 & 12 & \\
s^2 & 17.5 & K & \\
s^1 & 12-\frac{8K}{17.5} > 0 & & \\
s^0 & K > 0 & &
\end{array}$$

$$12-\frac{8K}{17.5} > 0 \quad \Rightarrow K < 26.25$$

$$GH(s) = \frac{K(s+1)}{s(s+6)(s+3)(s+4)}$$



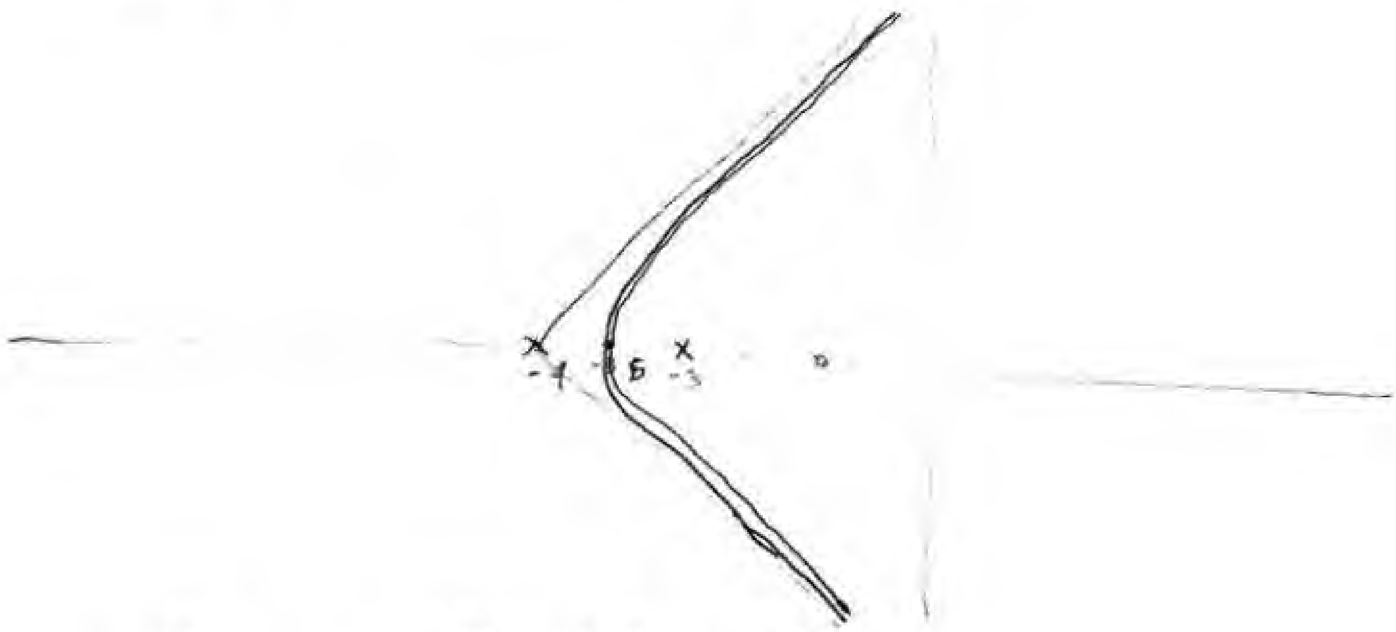
$\boxed{4}$

Asymptotes

number = $4 - 1 = 3$

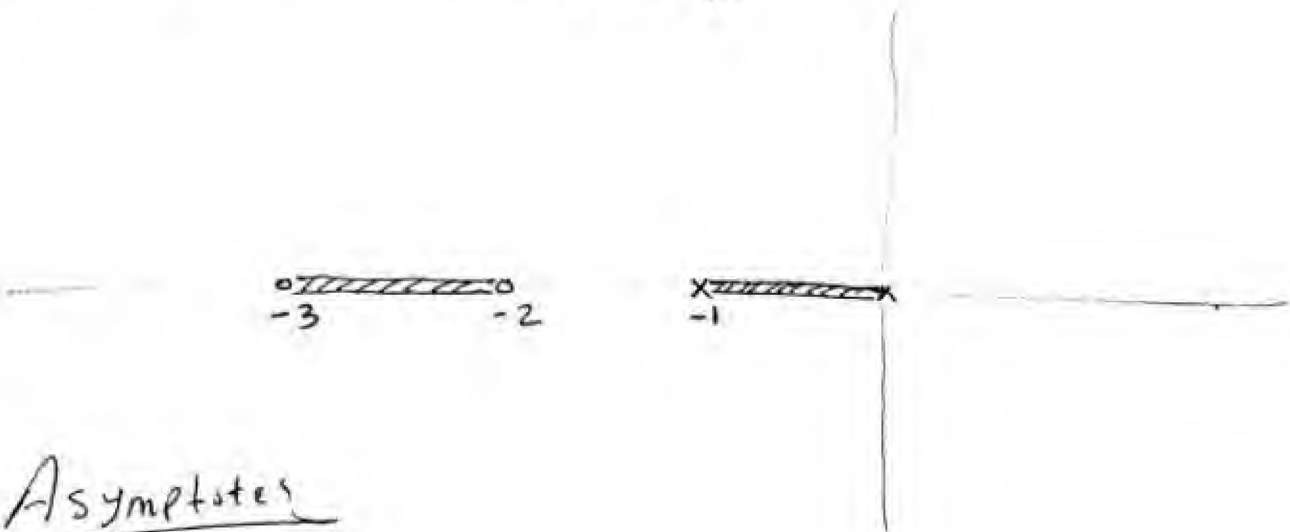
$$\sigma = \frac{-6-3-4+1}{3} = -4$$

$$\theta = 60,\ 180,\ \underset{\hookrightarrow -60}{300}$$



$$K = -\frac{s(s+3)(s+4)(s+6)}{s+1}$$

$$* \quad GH(s) = \frac{K(s+2)(s+3)}{s(s+1)}$$



Asymptotes

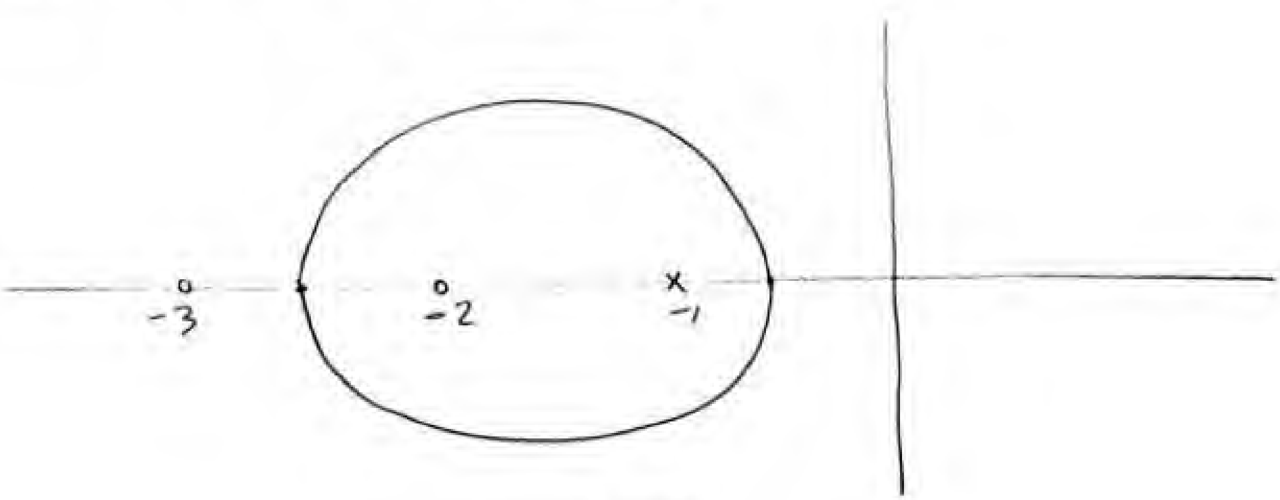
number = 0

Breaking points

$$K = \frac{-s(s+1)}{(s+2)(s+3)}$$

out: $0 \rightarrow -1$ (max K_{max})

in: $-2 \rightarrow -3$. (K_{min})



Report

Prove that the root locus must be circle.

Report Plus

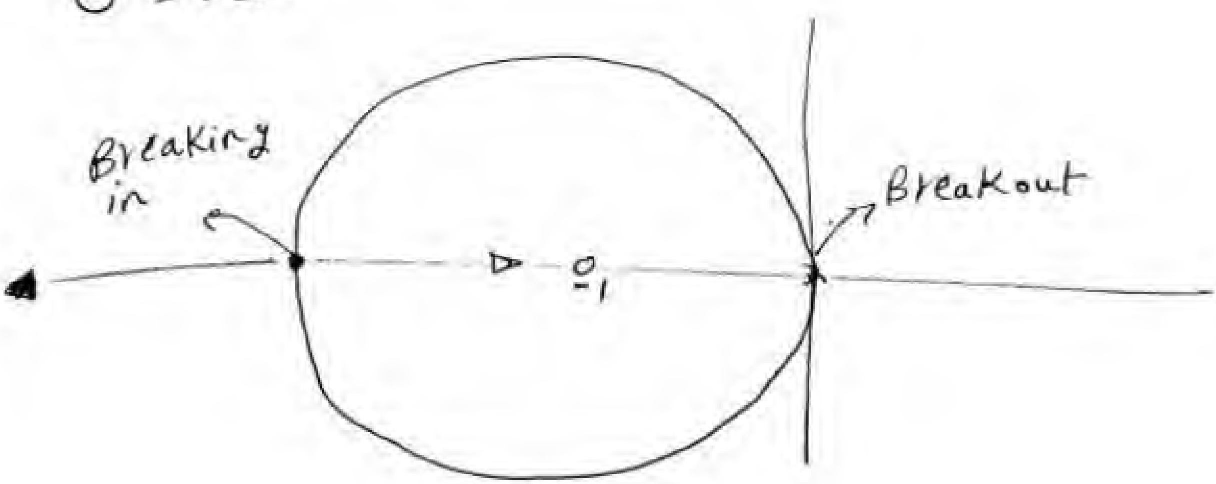
hint: Angle Condition

$$GH(s) = \frac{K(s+1)}{s^2}$$

Asymptotes

number $= n - m = 1$

$\theta = 180$



```
num = [1   5   6] ;
den = [1   1   0] ;

G = tf [num, den] ;
r/locus (G)
```

← جربها على الماتلاب.